CEMENT MILL SECTION of Concrete

The Cement Mill Edition of Concrete is edited exclusively for those interested in the manufacture of portland cement. Its pages are devoted to discussions of plant design, management, operation, production efficiency, chemical research and control, quarry operation, progress and news of the industry.

The Cement Mill Edition also contains all the material published in the corresponding Regular Edition and so provides news of the uses and merchandising of the materials whose manufacture is discussed in the Mill Edition. The Regular Section furnishes mill operating officials and mill executives valuable points of contact with the users of the materials they produce.

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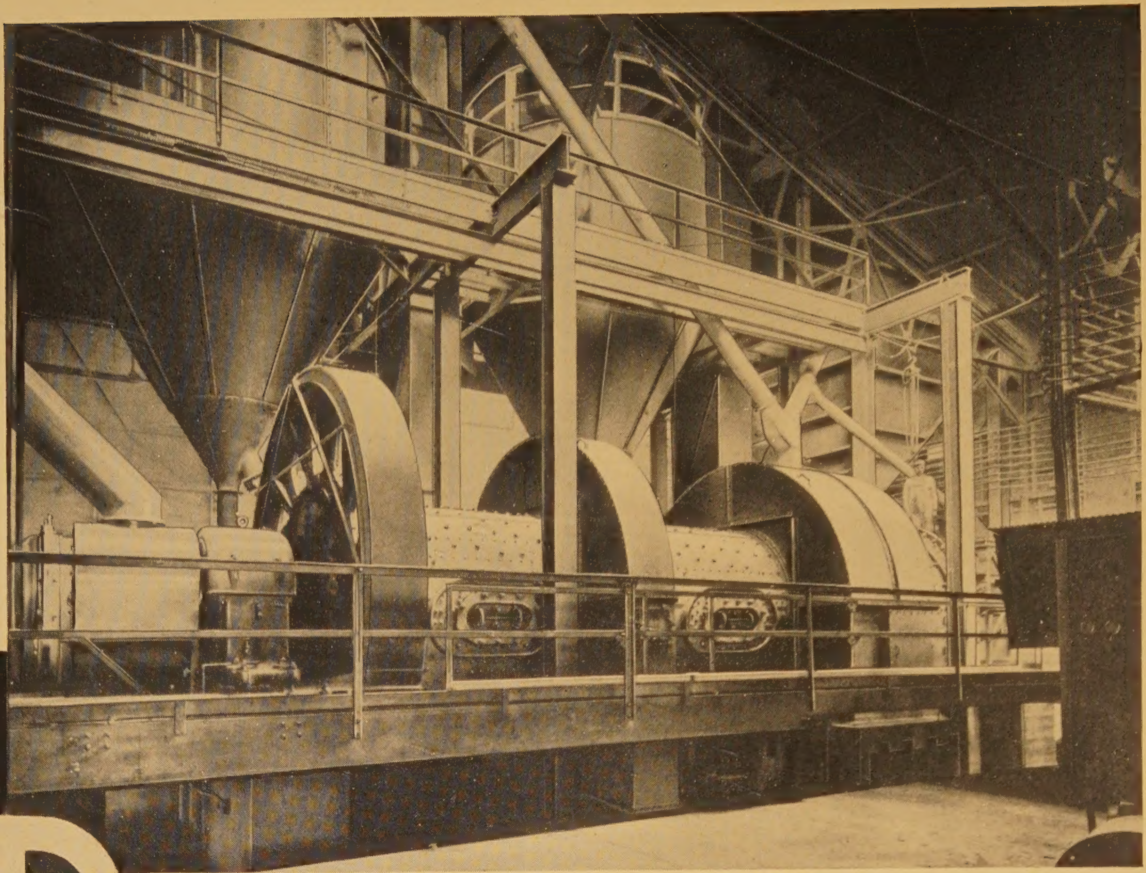

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Large Scale Cement Research

Three Years' Operation of an Experimental Mill Has Resulted in Much Practical Information on Cement Manufacture

By J. C. WITT
Chemical Engineer, Universal Atlas Cement Company, Chicago

Educated along chemical and mechanical engineering lines, Dr. Witt, the author of this article, has been associated with the cement industry almost continuously since leaving school. He has served as superintendent, chemical engineer, and in research and consulting capacities. He is a member of the A. S. M. E. and the A. I. Ch. E., and is interested particularly in the application of science to industry.

—The Editors.

AT the Buffington (Indiana) plant of the Universal Atlas Cement Company, there is an experimental cement mill which has been in practically continuous operation during the last three years. Construction was begun in 1928, and the first run of the kiln was made June 7, 1929. The data heretofore obtained are being studied and correlated, and further work is being planned.

This mill has certain noteworthy features. It represents one of the most extensive researches on cement manufacture that has been undertaken on so large a scale of operation. The selection of pulverized coal for fuel, the size of the kiln and the tube mill, and the use of the company's commercial raw materials, render the information obtained directly applicable to full scale manufacturing problems. The clinker and cement produced are studied in detail—from microphotographs to concrete beams and cylinders. The relation of theory to practice is kept in sight at every step.

Relation to General Research Program

The experimental mill is operated in connection with the general research program.[1] In this article the general program will be discussed very briefly, with the object of explaining the relation of the mill to the other activities of the chemical department.

There are two divisions of the chemical department—the plant laboratory, and the research and miscellaneous. The former division comprises nine plant laboratories. The work of these is largely in connection with commercial plant operation, but they co-operate on research projects. The research division has facilities at Buffington and at Northampton, Pennsylvania. Only the former will be discussed here. The research laboratories are well equipped for work in the fields of analytical, inorganic and physical chemistry, and microscopy. The chemical engineering laboratory contains mills, furnaces and other equipment intermediate between the research laboratories and the experimental mill.

Figure 1 shows the route of a research project. Independent of its source, it is first tried out in the research laboratories. If the indications of the preliminary work are favorable it is sent to the experimental mill, either directly or via the chemical engineering laboratory. If indications continue favorable, it is ready for a trial run in one of the commercial plants. As the diagram shows, the project always goes through the experimental mill before reaching the commercial plants. The research laboratories are in close touch with the work at every point.

Building and Equipment

The mill equipment was erected in an unused building which formerly housed an electric sub-station. The floor plan is shown in Figure 2, and the exterior in Figure 3. It is a brick building having a concrete floor. The main room is about 32 by 86 ft. A smaller room is occupied by the chemical engineering laboratory, and there is a basement under a large portion of the building. At the front a concrete ramp and wide doors provide for the entrance of trucks. Adequate facilities for electric current, compressed air and water have been provided.

The principal equipment consists of the following: jaw crusher; tube mill, 3 ft. 6 in. by 8 ft.; air separator; air

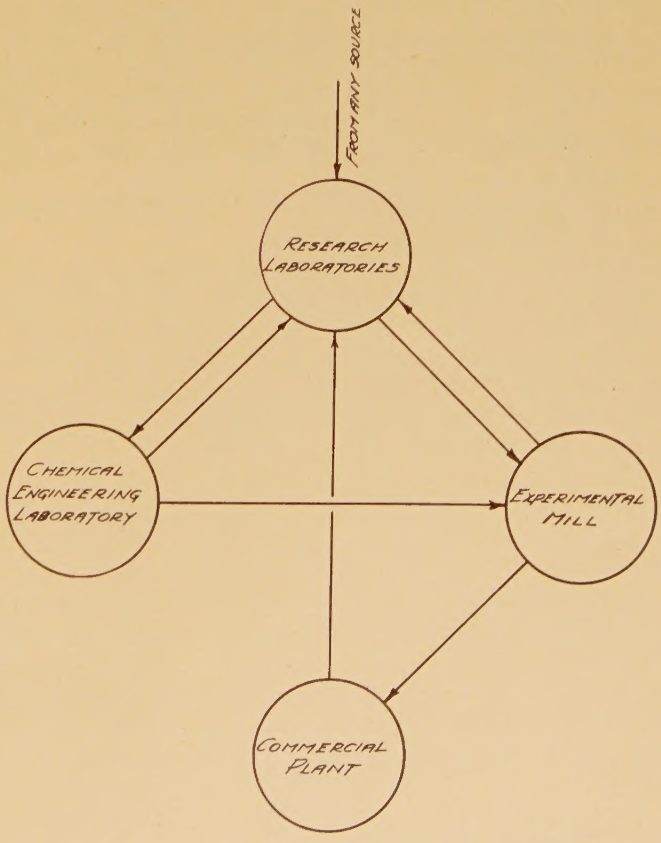

Figure 1. Route of a research project

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[1] *The Chemical Bulletin, 18,* 202 (1931).

lift; motor driven hoist; scales, 120-lb. and 500-lb.; kiln, 4 ft. by 35 ft.; and blast fan, 30-in. (See Figures 4 and 5.) Each machine unit is driven by a separate motor. The kiln is lined with ordinary 6-in. fire brick, except in the clinkering zone, where there are high-alumina brick. At the time the mill was designed the company used only pulverized coal for burning clinker, and it was decided that the kiln should be equipped for coal rather than oil, although the latter would have been more convenient for an installation of this type. All the equipment mentioned, except the crusher, is on the main floor. The crusher is in the basement and is so placed that it may be fed from either the basement or the main floor. The basement contains also the clinker bins and some storage facilities.

Some misgivings were felt concerning the quality of clinker that could be expected from a 35-ft. kiln. For a raw mix of given composition and fineness, the clinker might be inferior to commercial clinker, and only relative comparisons could be made. However, the clinker made on the first run, using commercial raw mix, passed standard specifications. It may be said that the clinker compares favorably with that from commercial kilns, notwithstanding the obvious difficulties in the way. Of course, careful handling and burning at sufficiently high temperatures are required.

The experimental mill described in this paper has certain noteworthy features. It represents one of the most extensive researches on cement manufacture that has been undertaken on so large a scale of operation. The selection of pulverized coal for fuel, the size of the kiln and the tube mill, and the use of the company's commercial raw materials, render the information obtained directly applicable to full scale manufacturing problems. The clinker and cement produced are studied in detail—from microphotographs to concrete beams and cylinders. The relation of theory to practice is kept in sight at every step.

Data are being studied in detail by the aid of curves, charts, diagrams, and other devices. Some new methods have been developed for calculating constitution on a different basis from those in common use. When the mill was started, the development of new products was not given a place on the program. As the work progressed, however, new formulas and new procedures presented themselves. The information on raw materials and processes now available provides a foundation for any development work that may be undertaken in the future.

Raw Materials

There are two classes of raw materials, which may be called the regular and the special. The regular raw materials have been the limestone and blast-furnace slag, used commercially at Buffington, as well as cement rock, limestone, shale and clay from the other plants of the company. The special materials include lake sand, seismotite, iron ore and bauxite, which are used in relatively small quantities for adjusting the composition of the raw mix.

Before starting the mill, facilities were provided for obtaining—from the commercial plant—stone and slag dried and ground to approximately 20-mesh. These materials are trucked to the experimental mill and unloaded into the storage bins. Pulverized coal is trucked from the commercial plant as needed. Usually it is reground at the experimental mill.

The special materials are received a few tons at a time, dried, crushed, ground, sacked and stored until needed. Each lot of raw materials is given a number, sampled and analyzed.

General Operating Procedure

The operation of an experimental mill involves many of the problems of a commercial unit, and some in addition. The fundamentals[2] are the same. The experimental mill deals with changing formulas and procedures. The commercial unit is on a much larger scale, but has more automatic and labor-saving equipment.

The principal raw materials are weighed in wheelbarrows on a platform scale. The special materials are weighed on hand scales, transferred to paper bags, and then added to the principal materials. The mixture is then ground by passing through the tube mill one or more times, using either the open or closed-circuit method. The raw mix is analyzed and the composition is adjusted if necessary. It is then transferred to the kiln hopper by means of the air-lift.

The kiln is fired usually about eight o'clock in the morning. After the desired temperature has been attained, the raw mix feed screw is started. The first clinker is received in the *reject* bin. When the quality is considered optimum, the bin damper is thrown and the clinker for the remainder of the run goes into the *retain* bin. Here it may be either air-cooled or water-cooled.

The clinker is crushed to about ¼-in. size, and, after the addition of gypsum, it is ground to the desired fineness in the tube mill, with or without air separation. Frequently portions of the same clinker are ground to different finenesses.

Originally it was intended to provide separate tube mills for raw materials and clinker, and materials-handling equipment similar to that in commercial plants. It was decided, however, to install only the minimum equipment necessary for the desired results, replacing mechanical equipment with hand labor wherever possible. After the mill had been running a few weeks a number of labor-saving devices were installed and some short cuts were developed. It was found possible to operate with less than half the labor at first considered necessary.

The mill was placed into operation some time before it was completed because of the urgent need for information. The kiln, tube mill and air-lift were in place, but facilities for storing and handling raw materials, clinker and cement were absent. During the first month or two much of the time was devoted to working out the details of operation, making minor changes and adjustments on the equipment, and providing the additional facilities required for satisfactory operation. Repeated changes in the speeds of the raw mix screw, the coal screw, and of the kiln itself were necessary. The tube mill feeder and air-lift required much adjustment.

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[2] Chemistry and the Portland Cement Industry. J. C. Witt. *Chemical Age, 31,* 171-3 (1923).

During the first few burns the clinker was received in steel drums and then dumped on the floor under the kiln. This was a very unsatisfactory arrangement and costly in labor. Later, an opening was made in the floor, at the discharge end of the kiln, and a Y-shaped chute, provided with a damper, was installed. Two steel clinker bins were built at the lower end of the chute, in the basement. By means of this arrangement the clinker may be handled readily, and the reject material, produced at the beginning of a run or during operating difficulties, may be kept separate from the clinker to be retained. To improve the ventilation of the basement the blast air is drawn from a point just above the jaw crusher. This arrangement results in some preheating of the blast air, and although no efficiency tests have been made, it is probable that there is a saving in fuel.

The air separator (see Figure 4) was not in the original plans, but was installed later for the study of open and closed-circuit grinding. A motor-driven hoist and some raw-material bins were placed on the first floor. Platforms, railings, electric wiring and additional machine guards have been completed little by little.

Records

The objective has been to operate the mill with efficiency so that all the information possible could be realized in return for the expenditure, and that nothing would be overlooked or lost. A procedure for handling records, samples and reserve stocks was formulated before the mill was placed into operation, and this has been improved as the work progressed. The unit of operation is the *burn*, or one run of the kiln. All records, reports, sample tickets, etc., are stamped with the following:

EXPERIMENTAL MILL

Burn No. ____________

Material ____________

Date ____________19____

Project No. ____________

All original records are filed. As the results of tests and investigations become available, they are transferred to a series of mimeographed data sheets, shown in condensed form in Tables 1 and 2.

Discussion of Results

So great a mass of data has resulted from the operation of the experimental mill that no attempt will be made in this paper to present even a summary. Just a few general statements will be made. Outlines of the investigation have been made from time to time, some before the mill was built and some after it was in operation. Each outline was larger than the preceding one, and it became evident that the scope of the work could be considered infinite, that the time would not come when the information desired would be complete.

The investigation started with a general survey of the composition field for the Buffington raw materials—that is, the extremes in calcium oxide, silica, alumina and ferric oxide. This naturally led to consideration of the fundamental processes of burning and grinding, and so on, until almost every phase of cement manufacture has been included.

Two general types of information have been obtained: (1) plant operation, and (2) characteristics of the product. The plant information has resulted from the actual handling of the various materials and the operation of the equipment. Conditions are under more careful control than in the commercial plant, and the range in the composition of clinker is much greater than could be attempted in actual manufacturing practice. Conditions that would be encountered in a commercial plant only as a result of some accident or irregularity of some sort, and would have to be eliminated as rapidly as possible, are here

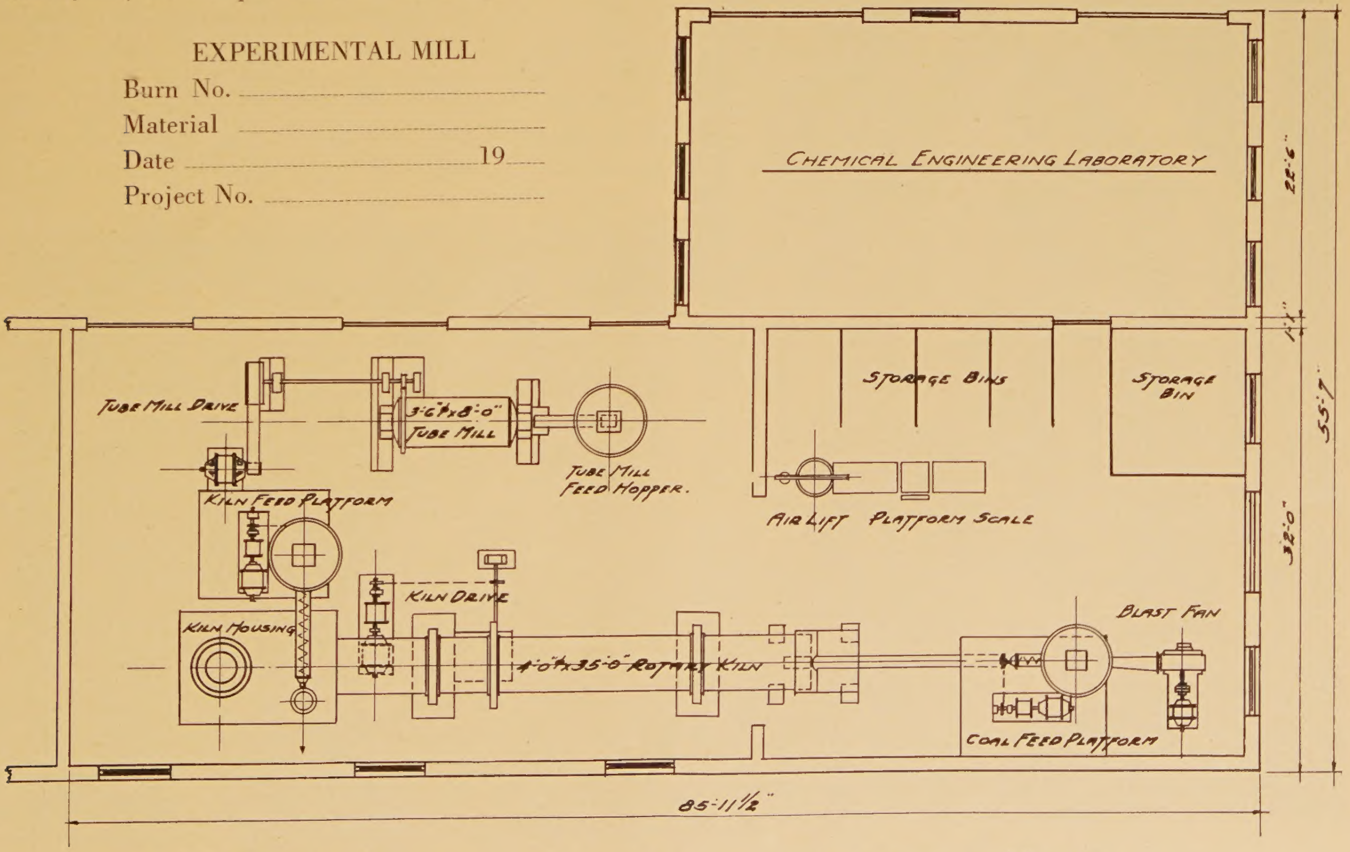


Figure 2. Floor plan of experimental mill and chemical engineering laboratory

allowed to run their course and studied accordingly. Many observations have been made on the preparation of raw mix, by open- and closed-circuit grinding, proportioning, blending, kiln operation, pulverized coal preparation, behavior of refractories, the cooling of clinker, and many other items.

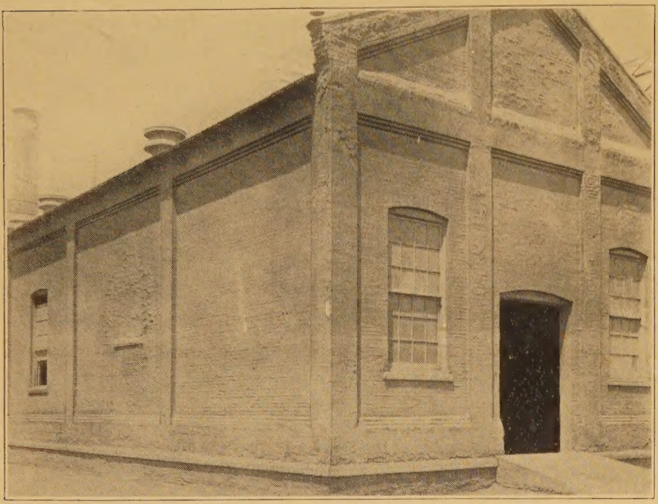


Figure 3. Exterior of building

The mill control is rigid. Raw mix is not introduced into the kiln until composition, fineness and uniformity are within the desired limits. The kiln is operated carefully with the aid of pyrometers at front and rear, draft gauges, speed counters and gas analysis equipment. The clinker is sampled repeatedly and examined by the petrographic microscope for uncombined calcium oxide and crystalline structure, and on this basis, together with its general appearance, the division between *reject* and *retain* clinker is made.

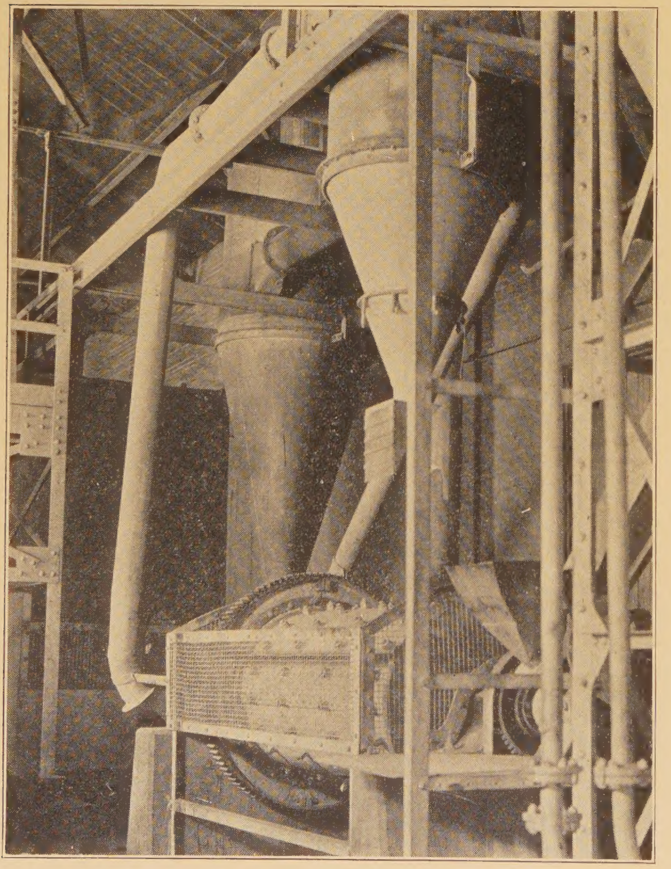


Figure 4. Tube mill and air separator

It may be considered that one function of the experimental mill is to furnish the laboratories with research materials outside the range of those regularly obtainable from commercial plants. The clinker is given a complete chemical analysis, including a volumetric uncombined calcium oxide determination, a petrographic examination, and in some cases physical, chemical and x-ray measurements. Approximately 400 or 500 lb. are set aside for any further research or tests that may be desired. A sufficient quantity is ground to provide for the chemical and physical tests of all kinds and a reserve stock of several hundred pounds. The work with cement includes routine physical tests, concrete cylinders, specimens for exposure under various conditions; expansion and contraction measurements, and such additional items as may be selected.

Data are being studied in detail by the aid of curves, charts, diagrams, and other devices. Some new methods have been developed for calculating constitution on a different basis from those in common use. When the mill was started, the development of new products was not given a place on the program. As the work progressed, however, new formulas and new procedures presented themselves. The information on raw materials and processes now available provides a foundation for any development work that may be undertaken in the future.

TABLE 1. SOME MINIMA AND MAXIMA

Item	Minima	Maxima
Clinker analysis (per cent)		
Silica	13.84	24.03
Alumina	2.43	14.06
Ferric oxide	1.20	12.70
Calcium oxide	60.50	69.42
Magnesium oxide	1.12	3.37
Ratios		
$\frac{SiO_2}{R_2O_3}$	0.73	5.01
$\frac{Al_2O_3}{Fe_2O_3}$	0.49	5.45
Raw mix fineness (per cent on 200-mesh)	1.2	18.2
Cement fineness (per cent on 200-mesh)	0.2	17.2
Cement setting time (Vicat; hours and minutes)		
Initial	0:10	3:20
Final	1:20	8:00
Kiln temperature (deg. F.)	2463	2932
Mortar tensile strength (1:3; pounds per sq. in.)		
1 day	113	478
7 days	72	635
Concrete compressive strength (pounds per sq. in.)		
7 days	1402	5810
28 days	3042	6138

TABLE 2. EXPERIMENTAL MILL DATA

Condensed from set of data sheets used for each burn

Burn number
Date: from (m.) to (m.)
Total kiln operating time (hours)

Raw Mix

Raw materials
Chemical analysis
Fineness of kiln feed (per cent on 200)
Time of mixing (hours)
Raw mix for total clinker (pounds per barrel)

Coal

Proximate analysis as burned
Ultimate analysis
Fineness (per cent on 200)
Analysis of ash
Coal for burning total clinker (pounds per barrel)

Weights of Materials

Raw mix supplied to kiln (pounds)
Screw counter readings .... Start Reject Retain
Total coal supplied to kiln (pounds)
Screw counter readings .... Start Reject Retain

Kiln Operation

Average temperature in back housing (deg. F.)
Average temperature of clinker in kiln, optical pyrometer (deg. F.)
Average temperature of clinker leaving kiln (deg. F.)
Average draft in back housing (inches of water)
Average static pressure in blast pipe (inches of water)
General burning conditions
Manner of cooling
General appearance of clinker
Gas analysis .... Sample point

Clinker

Raw mix per barrel of clinker
Analysis
Microscopical examination

Clinker Grinding

Weight of clinker (pounds)
SO_3 in gypsum (per cent)
Weight of gypsum (pounds)
Preliminary fineness of clinker,
per cent on 20-mesh 100-mesh 200-mesh
Time in tube mill (hours)
Analysis of cement: Volatile (per cent) SO_3 (per cent)

Physical Tests of Cement

Setting time (Gillmore) .... Initial Final
Setting time (Vicat) .... Initial Final
Fineness (per cent on 200)
Soundness (in steam)
Soundness (in air)
Expansion
Tensile strength
Compressive strength (concrete)
.... cylinders (........ for each period)
Aggregate size .... inches
Water-cement ratio
Fineness modulus

Additional Tests or Research

Chemical
Microscopical
Physical

Table 1 shows some of the low and high values in the chemical and physical data. The concrete cylinders are 6- by 12-in. The mix, by volume, 1:5 (average); fineness modulus of aggregate, 5 (average); water-cement ratio, 1.0.

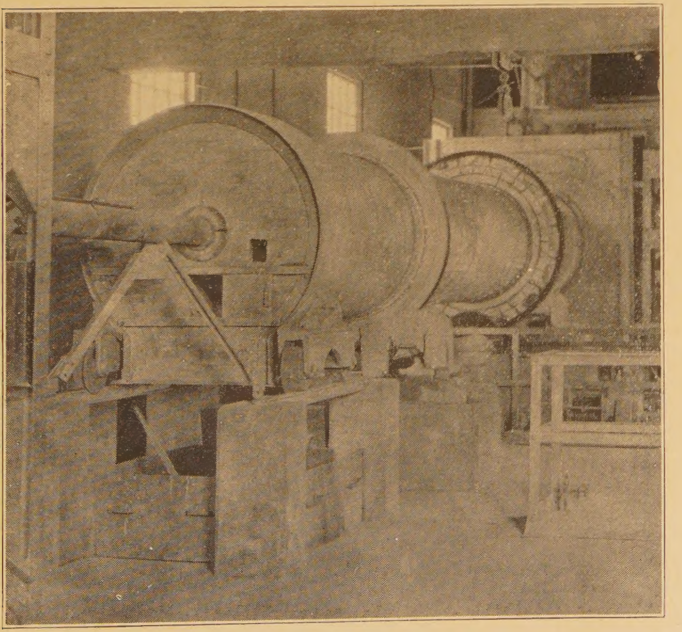


Figure 5. The kiln

Temperature Resisting Cement to Be Made by Medusa

Equipment for the manufacture of a temperature resisting cement is to be installed at the York, Pa., Manitowoc, Wis., and Bay Bridge, Ohio, plants of the Medusa Portland Cement Co. An installation costing $10,000 is already under way at the Ohio plant.

The product, of German origin, permits opening of the road to traffic immediately after placing of the concrete. A trial section has been placed by the Pennsylvania state highway department and is under observation.

Minnesota Highway Cement Award to Dewey Portland

The Dewey Portland Cement Co. plant at Davenport, Iowa, has been awarded a contract for furnishing 150,000 bbl. of cement for Minnesota highway work, half to be furnished this year and half in 1933.

The Cement Industry of California from 1902 to 1932

Good Prospects in Future World Markets—Revival to Find Some Mills in Bad Shape—Greatest Faith in San Francisco Industrial Area

By EDWIN C. ECKEL
Consulting Geologist, Washington, D. C.

THE present summary of the growth of the California cement industry during the past three decades is, very indirectly, the outgrowth of work carried out in that state during 1931 and 1932 in connection with a legal matter which is now, so far as the writer is concerned, completely and satisfactorily ended. In the course of preparing the cases in question, rather careful studies were made of the raw material supplies of certain critical areas in the state; and as the results of these studies have some general value, they have been summarized and published elsewhere.

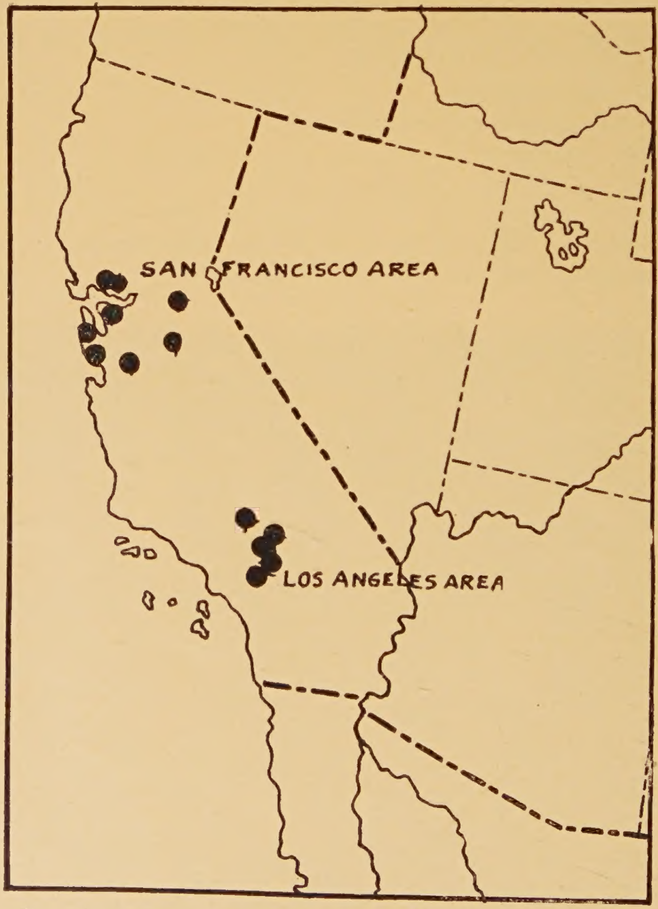
Entirely aside from these geologic results, however, it seems that certain data relating to the economics of the California cement industry will have practical value, now or later, in planning further development in that general Pacific Coast region. In the present article I have therefore assembled data regarding the past growth of the California cement industry, the rates at which it has progressed in output, and have added to these data comparisons with growth elsewhere in the United States, and certain suggestions as to future probabilities. In doing this I have used only output and price data which are already matters of published record, and have carefully refrained from making use, even by suggestion, of details which came into my hands as a part of my recent work in the tax cases mentioned above.

Locations and Dates of California Mill Construction

As a convenient starting point for the discussion, I have tabulated below the California cement mills which have been built and put into actual operation, with their locations and the dates at which they started production. It will be seen that only one of them—the California Portland Cement Co. mill at Colton—dates back into the last century, so that the dating in the title of this paper fairly covers the entire development of the California portland cement industry.

1. California P. C. Co. (1893), Colton, San Bernardino County.
2. Standard P. C. Co. (1903), Napa Junction, Napa County.
3. Pacific P. C. Co. (1903), Suisun, Solano County.
4. Santa Cruz P. C. Co. (1906), Davenport, Santa Cruz County.
5. Cowell P. C. Co. (1907), Cowell, Contra Costa County.
6. Riverside P. C. Co. (1909), Riverside, Riverside County.
7. Los Angeles Aqueduct Comm. (1910), Monolith, Kern County.
8. Golden State P. C. Co. (1911), Oro Grande, San Bernardino County.
9. Southwestern P. C. Co. (1916), Victorville, San Bernardino County.
10. Old Mission P. C. Co. (1918), San Juan Bautista, San Benito County.
11. Pacific P. C. Co. (1924), Redwood City, San Mateo County.
12. Yosemite P. C. Co. (1926), Merced, Merced County.
13. Calaveras P. C. Co. (1926), San Andreas, Calaveras County.

In considering the above tabulation, attention must be called to the fact that several of the mills above listed



Location of cement mills built in California in period from 1902 to 1932 are now shut down more or less permanently, and in at least one case finally scrapped, so that the number of existing mills in California which would become active in any ordinary business year is probably not more than nine or ten. Another notation might be made regarding ownerships and names, which have changed in several instances since building. Perhaps it would be a fair statement of the situation to say that if 1932 had been a year of normal cement demand, California would have operated not more than ten cement mills, under not more than eight ownerships.

On looking over the preceding list, with the geography of the state in mind, it is notable that of the thirteen locations at which California cement mills have been built, eight were in central California, five in southern California, and none in the northern third of the state. This original distribution is altered rather markedly if we consider that of the four mills which are either indefinitely or probably finally shut down, three are in central California and only one in southern California. In other words, if 1932 had been a normal business year, it is probable that five mills would have operated in the central or San Francisco district, and four (or possibly five) mills in the southern or Los Angeles market area. At the close of this paper, in discussing the future of the California cement industry in general, it may be possible to suggest something as to the probabilities in regard to future growth in the different regions.

TABLE 1. PORTLAND CEMENT PRODUCTION, CALIFORNIA AND UNITED STATES, 1902-1931

Year	Total United States, Bbls.	Bbls., California	Percentage of U. S. Production in California
1902	17,230,644	300,000 (?)	1.7
1903	22,342,973	500,000	2.2
1904	26,505,881	1,014,558	3.8
1905	35,246,812	1,225,429	3.5
1906	46,463,424	1,310,435	2.8
1907	48,785,390	1,500,000	3.1
1908	51,072,612	1,700,000 (?)	3.5
1909	64,991,431	3,300,000 (?)	5.1
1910	76,549,951	5,500,000 (?)	7.2
1911	78,528,637	6,317,301	8.1
1912	82,438,096	5,974,299	7.2
1913	92,097,131	6,159,182	6.6
1914	88,230,170	5,075,114	5.8
1915	86,891,681	4,503,306	5.2
1916	94,552,296	5,332,960	5.6
1917	90,703,474	5,653,362	6.2
1918	71,081,663	—	—
1919	80,777,935	4,642,679	5.7
1920	100,023,245	7,098,084	7.1
1921	98,842,049	7,073,000	7.0
1922	114,789,984	8,711,515	7.6
1923	137,460,238	11,001,910	8.1
1924	149,358,109	11,615,379	8.0
1925	161,658,901	12,941,000	8.0
1926	164,530,170	—	—
1927	173,206,513	—	—
1928	176,298,846	13,555,579	7.6
1929	170,646,036	13,091,899	7.7
1930	161,197,228	10,124,219	6.3
1931	125,358,309	7,740,168	6.2

Relative Growths of Cement Output—California vs. United States

The output of portland cement in California has increased from a few hundred thousand barrels around 1900 to a maximum of more than 13 million barrels at the top of the post-war boom in 1928-1929. During the same period the total United States output increased almost exactly tenfold, from 17 millions in 1902 to 176 millions at the crest.

In Table I these state and national outputs are arranged and in the last column of the table I have computed and tabulated the percentage, in each year, of the California output to the United States total.

It will be seen that the relative rise of California was rapid for the first decade, from around 1½ per cent in 1901 to more than 8 per cent in 1911. From then on there was a relative slowing down, carrying the California percentage down to 5 per cent in 1915, followed by a renewed rise to the old 8.1 per cent maximum in 1923. In later years, as in the whole period 1910-1931, the California average has been around 7 per cent.

Growth of Population

This cement increase was due in part, of course, to the rapid rate of growth of the population of California, which, beginning around 1900, displayed a rate of increase far higher than that of the average for the United States. As this is one of the important factors in the matter its data are summarized for the past four decades in Table 2.

TABLE 2. POPULATION GROWTH, CALIFORNIA VS. UNITED STATES

Year	Continental United States	California	Percentage of Total in California
1890	62,947,714	1,213,398	1.9
1900	75,995,575	1,485,053	1.9
1910	91,972,266	2,377,549	2.6
1920	105,710,620	3,426,861	3.2
1930	122,775,046	5,677,251	4.6

If we compare the cement outputs and population statistics at different critical dates, so as to determine the manner in which the production per capita has varied over a long period, we obtain the results summarized in Table 3. The highest per capita record must have been around 2.6 bbl. in 1928.

TABLE 3. CEMENT OUTPUT VS. POPULATION, CALIFORNIA

Year	Percentage of U. S. Population	Percentage of U. S. Cement	Bbls. per Capita
1890	1.9	0.0	0.0
1900	1.9	2.0	0.16
1910	2.6	7.2	2.3
1920	3.2	7.1	2.1
1930	4.6	6.3	1.8

Put into the simplest terms, the output of cement in California has not merely increased from several hundred thousand barrels to more than 13 millions annually in the three decades under review, but it has grown almost five times as fast as the output of the entire United States. These are both facts of interest not only to Californians but to cement manufacturers elsewhere, and it will pay to consider the way in which these surprising results were obtained and the main factors which seem to have brought them about.

San Francico Fire Stimulates Cement Industry

At the outset the state was of course underbuilt so far as cement mills were concerned—one mill, located in the extreme south, could not suffice to supply the requirements of a growing territory, or to keep out any large fraction of the imported cement shipped in from various producing localities in the East, in Europe and in Asia.

Two new mills built near San Francisco in 1902-3 would probably have filled their immediate market, if not overfilled it, had it not been for the San Francisco fire of 1906. That fire, the immediate effect of which was depressing in its financial losses, almost immediately gave a new impetus to cement consumption, not only in the San Francisco region but elsewhere on the Coast. The result was that even with the three additional mills built before 1910 there was steady and very profitable operation for the bulk of the California cement industry into 1911, a date when some other sections of the country were already experiencing the effects of overbuilding.

After a relative slight sharing in the cement troubles of the period 1912-1915, the California industry went ahead strongly to new high levels. In this it was aided, or forced, not only by the rapid increase in the population and average wealth of the state, but by the fact that there was a rather unusual amount of heavy construction requiring cement, as against some less fortunate market areas.

The Probabilities of Future Development

At a time of broad trade depression all over the world it may seem merely a waste of time to discuss the probabilities of future industrial expansion anywhere. Yet those who have lived through past trade booms and trade depressions ought at least to have learned two things of value—that every trade boom must ultimately come to an end with business collapse, and that every depression must ultimately come to an end as consumers' stocks are exhausted and business men regain confidence. Neither collapse nor regrowth are ever due in any large part to political action, and they are certainly not seriously induced or restrained by speech-making or laws. They come about because each new business generation has to learn to its cost that there are real limits to overproduction and inflation; and then after a period of bitter repentance it learns again that the world, year in and year out, needs more and more tonnages of many vital commodities.

So, at a time when many cement and steel mills are idle, there are always a few people who are already planning future expansion in their own lines. We may safely assume that the present depression, having come about from the usual natural causes, will pass away in similar natural fashion, entirely regardless of what any political party chooses to do with the Sherman or Clayton acts, or even with the tariff. It is, of course, a pleasant thing to assure some political leader that his policies or plans, and only his, can save the country. But there is no reason for any of us to take such assurances seriously ourselves. And that is true even as regards more purely financial remedies; during the 150 years of its national existence the United States has always found that industry revives, and grows to new heights, whenever current stocks of commodities begin to run short; and that when consumers need goods there is always some way found to finance the purchases.

Revival Will Find Some Mills in Bad Shape

Assuming, therefore, that a renewal of cement consumption is not far away, we can safely assume that it will find many mills in bad shape to meet any increased demand, particularly if that demand is rather strict with regard to quality and price. There are, we know, a good many plants of all sorts that are not really in good competitive condition or location; and this applies not only to cement, but to steel and many others of the heavy industries. When demand increases again the tonnages formerly produced by such mills will need to be replaced by new production, either in the same localities or in entirely new localities.

Location of Future World Market

In any such rebuilding of the industry, California seems bound to take an even more important place than in the past. In the East we are facing, for a generation perhaps, an exhausted continent from which we can expect competition rather than good markets. The countries of Europe may avoid communism, but they cannot be normally prosperous for several decades, if indeed there is ever any real reason to treat Europe in future as much more than a tourist resort.

The Gulf and the Pacific Coast, on the contrary, are looking toward South America and Asia, where steadily growing markets in many lines may fairly be expected for our goods of many sorts. It is difficult to avoid the conclusion that, whatever may happen in 1932 or 1933, the United States of 1950 will have its centers of population and industrial output much farther west and much farther Gulfward than they have been in the past. Increases in population, in trade activity and in wealth will give advantages in the way of increased demand to the cement and steel mills supplying the most rapidly growing sections.

Faith in San Francisco Area

In any future growth of the California cement industry, there will be no limit placed upon such growth by lack of good raw materials or of fuel oil. We may, therefore, expect to see new mills built, in new localities. My own personal judgment is that in the coming decades the central portion of the Coast, tributary to San Francisco harbor, is likely to see far more growth in all industrial lines than are the sections farther south or north.

In considering this matter of future mill construction in California, there are certain points which may be touched upon, very lightly, indeed. First, I think we can safely assume that of the thirteen mills tabulated and indicated on the map, two are partly or completely dismantled and will never operate again under any circumstances. Two others are in excellent mechanical condition, but are unlikely to be serious factors in the next development period, for easily understood reasons. Of the nine

(*Continued on page* 47)

EDITORIAL

To Regain That Lost Ground

THE improved feeling in the cement industry is well demonstrated in the manner in which the price advances announced in July and August have been maintained. Prices, at last, have the appearance of stabilization.

In other directions proof of improved sentiment has not been lacking. Manufacturers are now inclined to forget the differences of the past and to get together in a common effort toward the aggressive promotion of the interests of the cement industry as a whole. Recent meetings, held with this purpose in view, disclosed a determination that was as gratifying as it was surprising.

Aside from the grief resulting from the general business situation during the last three years, the cement industry has lost much ground. This ground can and will be regained if the present wave of good feeling is sustained.

Who Will Get the Rewards?

THE fundamentals have started on the upward climb—not a rapid climb, to be sure, but a climb that is so perceptible that it can no longer be waved aside as something artificial, created and directed for the benefit of the political party in power.

In the meantime, especially during the past three years, a large volume of deferred construction work has accumulated, most of which is sorely needed and much of which will go ahead when construction funds can be made available. In due time these matters will be straightened out and a deluge of pent-up construction awards will be turned loose.

When that time comes—and it may be much closer than most people think it is—contractors will need cement and cement manufacturers will need modern equipment to produce more cement. Not only will they need to produce more cement, but they must produce it at a lower cost and of a better quality than heretofore.

Both the equipment manufacturers and the cement manufacturers will participate in the improved order of things in direct proportion to their courage, their foresight, and their preparedness. Those who have kept their plants modernized and who have kept their products and equipment in the minds of potential buyers, through sustained sales and advertising efforts, are now in a position to reap the rewards.

Others may join in those rewards if they lose no further time in dilly-dallying; but the executive who continues to hold back with the idea of waiting "until there's more definite improvement" will find himself hopelessly outclassed. Before he finally swings into action his competitors will have too great a lead for him to overcome.

In the revived years to come there will be many new industrial leaders and some of the old leaders will be missing. The selection of these future leaders is being made now; and the selection is being made on the basis of that unrelenting law of nature—the survival of the fittest.

Better Feeling Among Users of Cement

IF sentiment within the cement industry has improved, as an editorial on this page asserts, it is likewise true that sentiment has improved among users of cement.

The truth of the statement just made is indicated in the chart printed in the construction section of this issue, showing a sudden jump in the monthly totals of contracts awarded for concrete roads. For the first time this year the monthly total (for August) exceeded the awards in the corresponding month in 1930 and 1931. The large increase in August was, moreover, a reversal of the seasonal trend. In addition, the total yardage awaiting award continues to be considerably ahead of last year.

This improvement in concrete highway contracts is in considerable measure due to the operation of the fund of 120 million dollars made available in the Federal Relief Act for federal-aid highway construction; but this is not the only reason for the increase. Credit is due also to the changed attitude of state highway officials, who recently have been awarding contracts for deferred work which, under normal conditions, would have been awarded earlier in the year. It is well known that much work was deferred last spring because highway officials hesitated to let contracts at the time when public sentiment was loudly demanding reduction in public expenditures without making any distinction as to the character of the expenditures, and state legislatures were threatening a wholesale diversion of highway funds to other purposes.

Now that the hysteria has subsided and improvement appears to have gained a definite foothold, some of this delayed work is being contracted.

It is gratifying to have this substantial evidence of improved sentiment among an important group of users of cement.

Shaft and Rotary Kilns

Compared in Efficiency

How Space Requirements of Zones Affect Heat Utilization—Fundamental Differences in the Two Types—Where Shaft Kiln Needs Further Development — Its Advantages and Disadvantages — Summary of Comparisons

By **O. FREY**
Chemical Engineer

IN considering the efficiency of the two kiln types—the high-capacity shaft kiln and the rotary kiln—the important points of comparison between the two types must be understood. Such comparisons are the basis for drawing some useful conclusions.

One of the most important points in such a comparison is the determination of the effect of the space occupied by the various zones, which in each type of kiln has a relation to its heat utilization.

In Figure 1 is shown the production progress through a high-capacity shaft kiln and a rotary kiln of approximately equal capacity.

Fundamental Differences in Two Kiln Types

The sketch (Figure 1) illustrates the fundamental differences in the operation of a high-capacity shaft kiln, as contrasted with that of a rotary kiln. From the sketch the ratios between the different zones may be recognized, although even greater differences exist between the two systems, particularly in the economic relationship. Thus it is seen that one shaft stands upright and that the other is rotated; the one is completely filled with material, the other is only a quarter full; in the one the fire makes unhindered progress through the mass, in the other it must work through the mass with difficulty. These are not the only points of difference; others entirely separate from these are seen in connection with the heat loss, due to the nature of the process. Here lies the most important point of difference, where the two systems are widely separated from each other. Therefore the author, in this article, desires to classify the advantages and disadvantages of these relationships.

Differences in Heat Loss

We know that different degrees of heat loss are found with both types of kiln. Briefly summarized, these are as follows:

(1) Zone I.—Evaporation of water and drying of raw materials, up to the beginning of red heat.

(2) Zone II.—Driving off of the carbon dioxide and heating up to the temperature of the clinkering zone.

(3) Zone III.—The clinkering zone.

(4) Zone IV.—The cooling zone.

ZONE I

High-Capacity Shaft Kiln

Temp. of gas at entrance to Zone I, approx. 1,300-1,400 deg. C.

Temp. of exit gas, approx. 150 deg. C.

Length of process, 1 meter.

Condition of material at exit from Zone I, dark red hot.

Rotary Kiln

Temp. of gas at entrance to Zone I, approx. 800 deg. C.

Temp. of exit gas, approx. 250-450 deg. C., depending on the system.

Length of process, approx. 20 meters.

Condition of material at exit from Zone I, dark red hot.

It will be observed that solely for the removal of water and for the dried material to be heated up to the beginning of red heat, the rotary kiln requires twenty times the length required by the shaft kiln. To the thorough preparation of the materials for the calcining zone the rotary kiln also owes the quietness of its operation. With the high-capacity shaft kiln we have a much more turbulent process, one result being that through the expulsion of moisture from the raw material much dust arises, which creates a nuisance throughout the factory.

With the rotary kiln we can count on a temperature drop of approximately 25 deg. C. per linear meter, while with the high-capacity shaft kiln this temperature drop appears in a length of about 2 cm. These figures speak for themselves and show also that in each case the drying operation succeeds best when it is given sufficient time for development. The graphical representation of the space required for drying and heating by the two types of kiln is shown in Figure 2.

Zone II Almost Non-Existent

It has already been shown that there is an extremely large difference in Zone I (the drying and heating zone) in the two types of kilns; but in Zone II (the calcining zone) a still sharper difference exists. The calcining zone of the rotary kiln requires a long stretch of the kiln (see Figure 1), while with the high-capacity shaft kiln this zone, practically speaking, disappears from the picture. In the sketch, Figure 1, the calcining zone and the clinkering zone are shown combined. From this follows a wider basic difference between the two kiln types. The rotary kiln, regardless of its capacity, maintains the same space relation between zones, while with increased capacity in a shaft kiln Zone I and Zone II remain the same.

Advantages and Disadvantages of Shaft Kiln

In these space relations between Zone I and Zone II lie all the advantages and disadvantages of the high-capacity shaft kiln as compared with those of the rotary kiln, the advantages being the small space requirement, the greatly

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Translated from *Zement*, issue of Feb. 11, 1932.

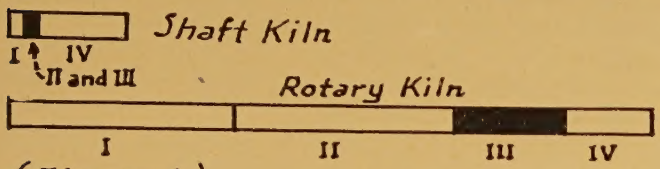
reduced heat radiation, better heat utilization, and slower deterioration of the kiln lining. On the other hand, the turbulence of the process quite often acts as a hindrance to the production of a completely burned, uniform clinker of the highest quality.

From these comparisons it becomes evident that with so short a space available for the drop in temperature in the calcining zone (Zone 2) of the shaft kiln, a preheating zone is not possible. Consequently the effectiveness of the clinkering zone (Zone 3) will depend on the condition which the material attains in passing through Zone I. For the high-capacity shaft kiln this condition is approximately as indicated in the following:

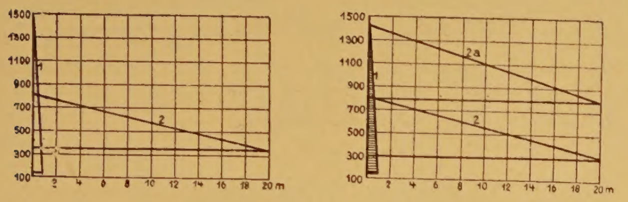
(a) Practically all the fuel is still present.

(b) The greater part of the carbon dioxide is still present.

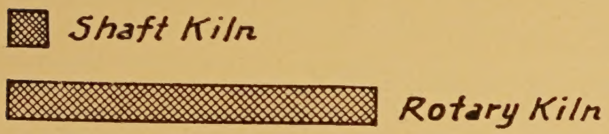
(c) At the outside surface the particles have a dark red glow.



(Figure 1)



(Figure 2)



(Figure 3)

Figure 1 (Above). Comparison of zones in shaft and rotary kilns. (I) Drying and heating zone. (II) Calcining zone. (III) Clinkering zone. (IV) Cooling zone

Figure 2 (Middle). Comparison of Zones I and II. (1) Drying and heating zone of shaft kiln. (2) Drying and heating zone of rotary kiln. (2a) Calcining zone of rotary kiln

Figure 3 (Below). Comparative space required for clinkering

Whereas the clinkering zone of the rotary kiln consequently receives a material which is already in the sintering stage and has lost all its carbon dioxide, thus being well prepared for the final transformation, the clinkering zone of the shaft kiln must work on a material which has given off scarcely a trace of its carbon dioxide, which is heated scarcely above dark red, and very probably the greater part of the particles have attained, at their center, a temperature not exceeding 300 to 400 deg. C.

A Three-Fold Task

The clinkering zone of the shaft kiln has, in consequence, a three-fold task to perform, namely, driving off the carbon dioxide, raising the temperature to that required for clinkering, and the actual work of accomplishing the clinkering. In order to accomplish this three-fold operation properly, it is necessary to maintain a very uniform temperature, in addition to keeping it somewhat above the normal temperature necessary for clinkering.

The operation of the shaft kiln, therefore, demands attentive observation and a complete understanding of parts of the process that are not visible to the eye.

The space needed for the clinkering requirements of the two types of kilns are in the proportion of about 1:10, as will appear clearly from Figure 3.

Where Further Development Is Needed

In the clinkering zone of each type of kiln approximately the same raw material is found. The material in the rotary kiln moves forward with five times greater speed than in the shaft kiln. This more rapid movement in the rotary kiln permits an intimate contact with the fuel gases, whereas the more solid formation of the material being burned in the shaft kiln creates a greater resistance. Here lies the principal point of weakness of the shaft kiln. The close formation of the mass of material hampers the proper contact with the oxygen of the air. These comparisons indicate points needing wider development in the high-capacity shaft kiln.

Important Improvement in Shaft Kiln

The Andreas process, through which the raw meal is introduced in crumbly or granulated form instead of briquettes, may well be only a halting place in further development. In the present-day high-capacity shaft kiln the clinkering zone, in consequence of the much stronger fans, may be more concentrated than formerly, when the draft attained was scarcely half that of the modern shaft kilns. This greater concentration, which naturally makes possible a more concentrated fire, is among the foremost advantages attributed to the stronger fans.

The Cooling Zone

The cooling zone follows the clinkering zone, beginning at the point where the clinkering process is ended and the temperature begins to drop; and with the high-capacity shaft kiln it ends, under normal procedure, with a kiln product having a temperature of about 50 to 100 deg. C. The fall in temperature, consequently, amounts to approximately 1,300 deg. C., which with a cooling shaft height of 8 to 10 meters, brings the cooling rate to about 130 to 150 deg. C. per linear meter. The corresponding rate of cooling in the rotary kiln is about the same, when its cooling zone is assumed to have the same length of approximately 8 meters. The size of the cooling zone, consequently, agrees quite closely in the two kiln types, so that the speed of the material in the rotary kiln is from 4 to 5 times as fast as in the shaft kiln.

The space requirement for heat utilization is also approximately the same with both kiln types, when the essential nature of the operation is considered. With the rotary kiln this process operates more favorably because of the greater agitation of the clinker material.

Summarizing the foregoing, the following points pertaining to the two kiln types may be tabulated:

High-Capacity Shaft Kiln:

In the preheating zone the water evaporation occurs rapidly.

No definite calcining zone evident.

Calcining zone and clinkering zone are combined.
Slow heat loss in the cooling zone.

Rotary Kiln:
In the preheating zone water evaporation is slow.
Calcining zone with temperature change at moderate rate.
Clinkering zone space requirement from 8 to 10 times greater than with shaft kiln.
Slow heat loss in the cooling zone.

It is remarkable that two methods so different in the character of the production process of the kilns can attain results so similar. It is further worthy of note that the shaft kiln, because of its shorter length, requires much less fuel than the rotary kiln. It is therefore evident that search must be made for means and methods whereby certain advantages possessed by the rotary kiln may be utilized in the shaft kiln, without losing the advantages which the high-capacity shaft kiln now possesses.

India's Cement Marketing Company Eliminates Price Cutting

Promotion Is Organization's Most Difficult Problem, Because of Vast Area and Many Languages—Use Illustrated Posters

By H. E. ORMEROD
The Cement Marketing Company of India, Ltd., Bombay, India

IN your issue of February, 1931, pages 90-91, you printed an interesting article written by Walter Buchler, under the heading "Marketing Company Sells India's Cement." In this article the author describes the marketing methods developed by The Cement Marketing Company of India, Ltd., whose head offices are in the Forbes Building, Home Street, Bombay, India.

The writer would like to present your readers some additional information on the activities of this marketing organization, and to take this opportunity of commenting on Mr. Buchler's article as follows:

(1) Prices have not remained stable since 1925, as after the Cement Marketing Company came into existence in 1930, a reduction averaging Rs. 5/- per ton was made practically in all the markets throughout India.

(2) Selling prices have been reduced since Mr. Buchler's article was written, and now they range from Rs. 43/- to Rs. 57/8/- per ton f.o.r. or f.o.b. destination.

(3) The present productive capacity of the Indian cement companies is very nearly one million tons, whereas the offtake is only about 590,000 tons—in other words, slightly under 60 per cent.

In this connection it is interesting to note that the "per capita" consumption of cement in pounds in various countries is as follows:

U. S. A.	558
Belgium	300
France	270
United Kingdom	230
Italy	150
India	4

Price Cutting Eliminated

With the formation of the above company, unprofitable price cutting has been eliminated, which is definitely a step in the right direction, as is appreciated by all.

The problem we now have to face is that of finding an economical means of educating a population, which is equivalent to one-fifth of that of the whole world scattered over an area which is as large as the whole of the Continent and a part of Russia, to the correct use of cement and cement concrete.

A Difficult Promotional Problem

To the immensity of the area and of population must be added the complication of language. Among the educated minority, English is the means of communication; but the last census showed that only 2½ million persons (16 in every thousand males and two in every thousand females) were literate in English. The last census, taken out in March, 1929, enumerates altogether 222 different vernacular languages in India.

Use of Illustrated Charts

The above figures will give you some idea of the immensity of the problem we are faced with in India. As a means of disseminating information on the proper use of cement we have prepared large posters with a view to bringing home to uneducated users the correct method of procedure. These posters are in the form of illustrated charts. Some of the posters are printed in English, although the majority we use are in vernacular.

South Dakota State Plant Gets Capitol Contract

The South Dakota state cement plant at Rapid City has been awarded the contract to furnish cement for the new state capitol at Bismarck.

Promoters of Cement Plant Served with Cease and Desist Order

The National Portland Cement Co., which proposes to erect a new cement plant near Allentown, Penna., was ordered under date of August 10, 1932, by the Pennsylvania Securities Commission, to cease and desist from publishing, circularizing and distributing the circular or prospectus that had been used in describing their offering of 7 per cent cumulative preferred stock in the company. The officers and directors of the company were ordered to appear for a hearing which was held in the offices of the Securities Commission on August 24.

As a result of the hearing the National Portland Cement Co. was ordered to destroy all copies of the circular and was requested to submit to the Commission a certification that such had been done. The cement company has submitted to the Commission a copy of a revised circular to replace the circulars which were ordered destroyed.

~ PERSONALS ~

Rapier R. Coghlan has severed his connection as chemical engineer for the Marquette Cement Mfg. Co. at Chicago, and is available for a new connection.

Mr. Coghlan has had a number of years' experience in research into materials and processes as well as operating chemist.

Frederick Williams Kelley, 52, president of the North American Cement Corp., Albany, N. Y., passed away Sept. 19, after a prolonged illness.

Mr. Kelley joined the Helderberg Cement Co. in 1900, as vice-president and general manager.

The Cement Industry of California from 1902 to 1932

(*Continued from page* 42)

remaining, some are in as good condition as in 1929; but there seems to be no reason to expect many of them to have improved with age. So, taking all factors into consideration, it seems unlikely that the mills now existent will furnish any oversupply during the next period of prosperity.

At the top of the 1929 boom there were, of course, a number of projects and promotions in hand; some were sound, others were frank get-rich-quick schemes. Some of these will doubtless be revived as times improve. The soundest of them all, from a purely commercial standpoint, seems to have been permanently blocked by legal difficulties—I refer, of course, to the Santa Monica project. Several of the existing companies are in position to build new mills, and that solution might be the best from a price standpoint. In any case it seems highly probable that new capacity will be needed by 1935 at the latest, and it is merely a question as to who supplies it.

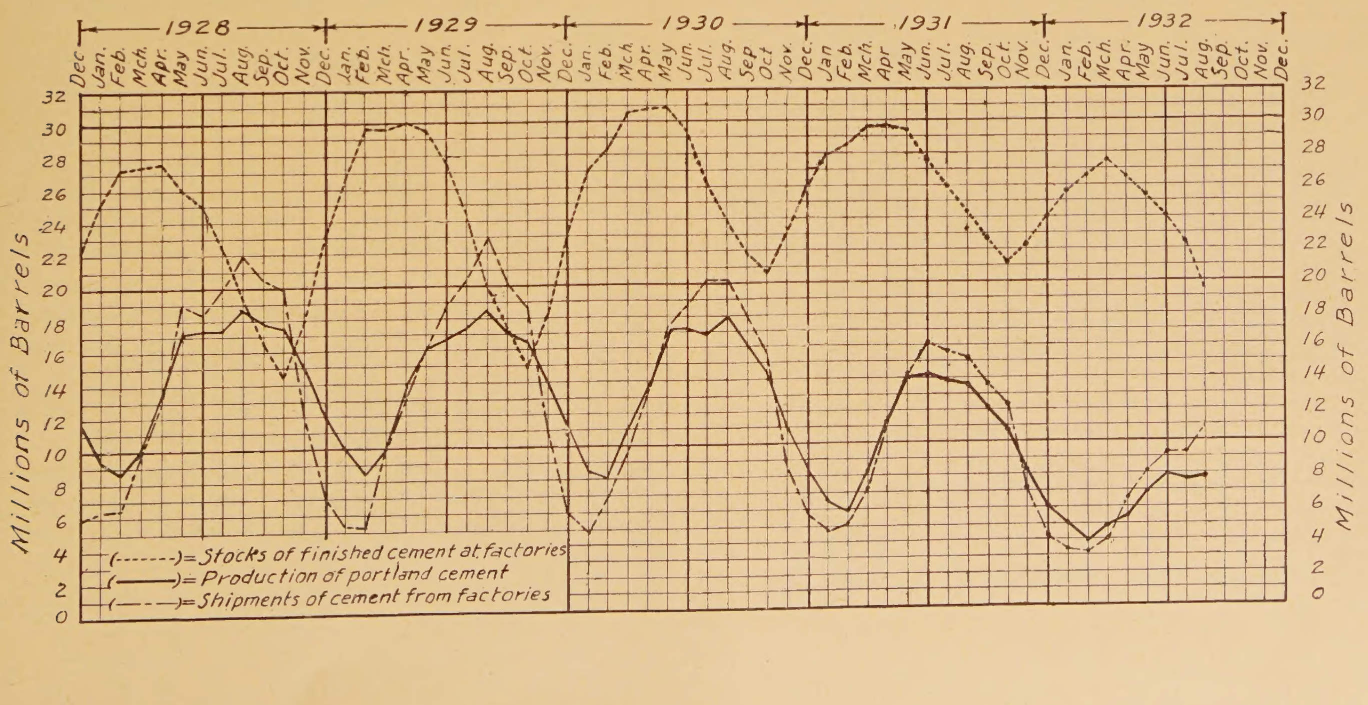
Cement Statistics for August

Relation of Production to Capacity

	The Month	Twelve Months
August, 1932	34.2	32.1
August, 1931	60.2	52.0
July, 1932	33.4	34.2
June, 1932	35.7	36.5
May, 1932	30.2	38.9

Production, Shipments and Stocks of Finished Portland Cement

	1931	1932
Production, August	13,549,000	7,835,000
Shipments, August	15,172,000	10,968,000
Stocks at end of month	24,313,000	19,379,000
Production for year to date	87,581,000	49,650,000
Shipments for year to date	89,136,000	54,217,000



Mill Equipment

Arc Welder Is New Product of Harnischfeger Corp.

The Harnischfeger Corp., Milwaukee, Wis., has developed a new P. & H. Hansen 42 h.p. gasoline driven arc welder. It is available in 100, 200, 300, 400 and 600 ampere sizes in stationary and portable types. The welder is built for quick accessibility and may be hooked onto any car and pulled to the location of the work.

Engines of all sizes run at 1,750 r.p.m. Welders are powered with Waukesha engines. These engines are equipped with Ricardo heads, pressure oiling systems and built-in governor. A large radiator insures ample cooling capacity. Self starters eliminate the cranking act.

A flexible coupling joins the arc welding generator to the gas engine. Each generator is equipped with a panel board containing flush type volt meter and ammeter, and cable terminal studs with large hand screw clamps. The single, easily operated control for regulating the welding current, 40 and 25-volt, is mounted on the commutator end of the generator. If desired, an auxiliary generator (1½ k.w., 120 volt d.c. generator on the 200 and 300 ampere size units, and a 2¼ k.w., 120 volt d.c. generator on the 400 ampere unit) can be furnished. This generator is mounted on end of the welding generator and furnishes current for light and tool operation.

Series of Brown Mechanical Flow Meters Launched

The Brown Instrument Company has rounded out its line of fluid measuring instruments by the addition of a series of mechanical flow meters. It is mentioned as a series because it has been developed in a number of combinations including: Square root and evenly divided charts; automatic planimeter; multipen,—flow—pressure—temperature; compensation for pressure and temperature; and automatic control and recording.

This new line of mechanical flow meters is featured by a simple direct lever-actuating mechanism, by a large powerful float, by a pressure tight bearing with grease reservoir, by a series of range tubes that permit changing the range of the meter without disturbing the orifice, and by a type of construction and assembly whereby the manometer may be taken apart and cleaned in the field without altering the calibration.

The model illustrated is representative of the entire new line. The instrument mechanism is built into a die cast aluminum case which is attached to the manometer assembly by means of a three-armed bracket that also supports the high and low pressure chambers of the manometer. The high pressure chamber is a drawn steel cup and the low pressure chamber or range tube is seamless steel tubing. The two are connected by means of the steel U-tube shown below the high and low pressure chambers.

This instrument can be furnished to record on either a square root chart or an evenly divided chart. The outward appearance of the two types is the same. The constructional difference lies in the transmission of the float movements to the recording pen.

The multipen models in addition to making a record of the flow, pressure and temperature, have been developed so that compensation for variations in the pressure and temperature of the fluid being measured can be automatically applied to the flow pen. That is, all multipen models are not provided with automatic compensation, but compensation for either one or both can be incorporated. Compensation is accomplished by varying a sensitivity lever between the manometer float and the flow meter pen automatically by means of a lever between the pressure or temperature responsive element and sensitivity lever. In cases of double compensation, that is, compensation for both temperature and pressure, the two variables are combined to give a net effect and this single net effect is applied to the movement of the sensitivity lever.

All recording models of this new meter can be provided with either hand wound or electric chart drive, and either can be furnished in a variety of chart speeds. The hand wound clock is mounted in a dust proof case with chromium-plated, stainless steel, and cadmium plated parts used where these materials have proved superior in service tests. The electric clock is a radical departure from the general type of clock construction. It is driven by a 60 r.p.m. synchronous motor with the gearing mounted on stainless steel studs on the underside of a single plate. The electric clock plate also forms the base for mounting the control mechanism.

Models incorporating automatic recording planimeters and totalizers carry a sector on the pen shaft. The shape of this sector depends upon the type of chart used, square root or evenly divided.

Combustion Eng'r'g Corp. Announces New Small Stoker

The Combustion Engineering Corp. has recently placed on the market a new underfeed stoker suitable for application to both heating and industrial boilers in the approximate range of 40 to 150 developed boiler h.p. Its fuel-feeding mechanism is of the ram or plunger type and comprises a main ram or pusher and auxiliary pushers, all mounted on a sliding plate which moves back and forth in the bottom of the retort. The grate surface is composed of stationary bars with moving elements or tuyeres which serve to agitate the fuel bed and make for more effective air distribution. Standard equipment includes dead plates on either side of the active grate surface, but at the option of the purchaser these may be replaced by easily operated shaking dump grates of sectional type.

Industrial Literature

Blasting Information Exams

An educational program for the explosives service men and salesmen of *Hercules Powder Co.* recently has been introduced by the company's explosives technical service division, according to an announcement by *J. Barab*, manager of the division. While all sales and service men are carefully trained originally, the course is designed to keep their technical knowledge fresh in mind and up-to-date.

Hercules explosives and blasting supplies, their properties and application, are the subject of these periodic examinations being given the salesmen by means of questionnaires. The novel program has been started to insure full advantage being taken by the salesmen of opportunities to inform themselves from the handbooks and other sales and service data which are sent out regularly by the company.

Field Activities

Foote Announcement

Bradford Foote, president of the *Foote Gear Works, Inc.*, Chicago, announces that the firm is in no way a part of, or in any way affiliated with Foote Bros. Gear & Machine Co., of the same city.